

Flexible Over the Wing Passenger Loading Bridge

[001] This application is a continuation-in-part of United States Patent Application No. 10/354,002 filed January 30, 2003, which is a divisional application of United States Patent Application No. 10/076,399 filed February 19, 2002, which claims the benefit of United States Provisional Application No. 60/352,850 filed February 01, 2002, and this application is also a continuation-in-part of International Application No. PCT/CA03/00221, filed February 18, 2003.

Field of the Invention

[002] The present invention relates generally to passenger loading bridges and more particularly to a flexible over-the-wing passenger loading bridge for servicing a rear doorway of a nose-in parked aircraft.

Background of the Invention

[003] In order to make aircraft passengers comfortable, and in order to transport them between an airport terminal and an aircraft in such a way that they are protected from weather and other environmental influences, passenger loading bridges are used which can be telescopically extended and the height of which is adjustable. For instance, an apron drive bridge in present day use comprises a plurality of adjustable modules, including: a rotunda, a telescopic tunnel, a bubble section, a cab, and elevating columns with wheel carriage. Manual, semi-automated and automated bridge alignment systems are known for adjusting the position of the passenger loading bridge relative to an aircraft, for instance to compensate for different sized aircraft and to compensate for imprecise parking of an aircraft at an airport terminal, etc. Of course, other types of bridges are known in the art, such as for example nose loaders, radial bridges and pedestal bridges.

[004] Unfortunately, aircraft aisle design is such that passenger flow rate along aircraft aisles is a limiting factor, which slows down the entire deplaning operation. That is, the aircraft doorways and most passenger loading devices are capable of handling substantially higher passenger flow rates than are the aircraft aisles. Of course, similar delays are also encountered during the boarding, or enplaning, operation. This limitation is of serious concern in a marketplace where airlines consistently struggle to shorten the turn-around time of their aircraft

in order to boost operating efficiency, lower operating costs and thereby offer lower fares to their customers.

[005] Accordingly, there has been much interest over the past several decades in developing ways of servicing plural doorways of a same aircraft, in order to reduce the length of time that is required to complete the boarding and deplaning operations for said aircraft. Although it is known to service more than one doorway in front of the wing of some types of large aircraft, for example using two separate apron drive bridges to service two different doorways, the actual time savings are nominal because some passengers must still traverse a long stretch of in-plane aisle in order to reach the nearer of the two different doorways.

[006] Some types of aircraft include a rear door through which passengers can enter and leave the aircraft by means of steps that are lowered from the aircraft onto the apron or tarmac, or by means of mobile steps that are connected to the door by ground personnel. One drawback with this approach is that it is necessary for passengers to walk onto the apron and then walk up steps into the passenger bridge. As will be obvious to one of skill in the art, it is not desirable for passengers to occupy the apron surrounding an aircraft, because of the safety risks involved. Additionally, accessibility may be a concern for some passengers, such as for instance a passenger using a wheelchair.

[007] An improved system for servicing a doorway behind or over the wing of aircraft equipped with such a doorway is required. In particular, many smaller types of aircraft, such as for instance narrow body aircraft, have only a single aisle along which passengers are able to traverse the distance between the front of the aircraft and the last row of seats in the back of the aircraft. By servicing the rear doorway, the length of in-plane aisle which the passenger must traverse may be reduced substantially, for example by a factor of up to two, with a corresponding reduction of the boarding and/or deplaning time. This is particularly desirable in the case of “stretch” models of aircraft, in which the length of in-plane aisle that must be traversed by passengers can be quite significant. This reduction in boarding and/or deplaning time not only avoids adverse passenger reaction, but also substantially increases safety during situations requiring fast deplaning as in the case of a fire on the ramp or in the aircraft at the terminal.

[008] There have been two basic techniques of positioning aircraft alongside passenger terminals to permit interconnection of the aircraft and the terminal using passenger bridges; these two techniques are parallel parking and nose-in parking. Parallel parking offers the advantages that the aircraft arrives and departs from its parked position under its own power, and thus requires no tow tractor in its turnaround cycle. Further, the orientation of the aircraft with respect to the terminal façade in parallel parking facilitates access to aircraft doorways either forward of or aft of the wing with known ramp supported loading bridges. Moore et al. in U.S. Patent 3,184,772, issued May 25, 1965, disclose a telescoping loading and unloading structure for servicing doorways forward of and aft of the wing of an aircraft parked in parallel relationship to a terminal building.

[009] However, parallel parking presents one very significant disadvantage. Parallel parking necessitates certain aircraft turning and maneuvering room, and therefore this technique requires greater terminal façade length than does the nose-in technique. Another disadvantage of parallel parking is that departure of an aircraft from a parked parallel position requires substantial engine thrust to start and turn the aircraft. As the aircraft departs, the exhaust of the aircraft engines is directed toward the terminal building and toward the ground equipment and personnel located adjacent the terminal with a resultant shaking of the terminal building and disruption of ground operation activities.

[0010] In view of these disadvantages, most modern terminals utilize nose-in aircraft parking. However, with nose in parking, it is generally necessary to cantilever or otherwise move a passenger loading bridge structure directly over the aircraft wing in order to service the rear doorway. One exception is U.S. Patent 3,808,626 issued to Magill on May 7, 1974, in which a self contained mobile passenger loading bridge for airplane loading and unloading operations is disclosed. The bridge comprises a three section telescopic passageway, which is pivotally connected to a terminal building at an inboard end via a stationary rotunda and to a moveable rotunda at an outboard end. A second, two section telescopic passageway is pivotally connected to the moveable rotunda at an inboard end thereof and has a cabin at an outboard end thereof for engaging a rear doorway of an aircraft. The bridge is essentially an elongated conventional apron drive bridge having an additional pivot point, i.e. the moveable rotunda, for steering the

outboard end behind the wing of a nose-in parked aircraft in order to mate the cabin to a rear doorway of the aircraft.

[0011] U.S. Patent 3,524,207 issued to Giarretto August 18, 1970 discloses an over-the-wing access structure for servicing multiple doors in commercial jet aircraft. The height of the structure is vertically adjustable in a level manner so as to accommodate vertical movement of the aircraft during loading and unloading. This system is both awkward and expensive. Furthermore, should power to the structure be interrupted when the outboard supports are deployed, it becomes impossible to move the aircraft away from the terminal building due to the supports blocking the path of the wings.

[0012] U.S. Patent 3,538,529 issued to Breier on November 10, 1970 discloses an overhead supported aircraft loading bridge, including a slightly arched telescoping tunnel section, which may be cantilevered over the wing of an aircraft for servicing a rear doorway thereof. The telescoping tunnel section is pivotally connected to a static structure, thereby providing additional freedom of vertical motion for clearing the wing and mating to the rear door of the aircraft. This system also is both awkward and expensive. It is a further disadvantage of this system that the overhead support arm must support the weight of the entire loading bridge. Accordingly, the loading bridge of US '529 is particularly unsuitable for use with "stretch" aircraft models, which models have rear doorways that are serviceable only using loading bridges having three telescoping tunnel sections. As will be obvious to one skilled in the art, an additional tunnel section would add unacceptably to the weight of the loading bridge disclosed by Breier.

[0013] U.S. Patent 3,722,017 issued to Gacs et al. on March 27, 1973 discloses an over-the-wing aircraft loading bridge having a main passageway member pivotally supported at the terminal building end on a track mounted rack propelled carriage. The main passageway member is elevatable and depressable so that its outer end portion, slightly arched, may extend over the wing of an aircraft. At its outer end the main passageway mounts a lateral passageway including an operator's cab, which is for being mated to a rear doorway of the aircraft. The lateral passageway appears to serve as a bridge between the rear doorway and the main passageway element, which passageway lacks sufficient freedom of vertical movement to engage

the rear doorway directly. It is a disadvantage of this system that the lateral passageway, including the mechanism for adjusting same, adds considerable weight to the unsupported (i.e. outboard) end of the main passageway member. The additional complexity of aligning such a bridge would increase the time required to move the bridge into alignment with the rear doorway, thereby negating some of the desired time savings. It is a further disadvantage of the system disclosed by Gacs et al. that additional bridge operators and gate control staff are required to service the multiple doors of the aircraft. For example, each doorway of the aircraft is serviced using a separate bridge having a separate entrance into the terminal area.

[0014] Anderberg in WO 9942365 discloses an over-the-wing bridge having a telescopic tunnel section pivotally connected to a rotunda at an inboard end thereof and terminating in a cabin at an outboard end thereof. The outboard end is supported using a vertically adjustable wheel carriage, which requires the outboard end of the tunnel to be driven outward and around the wing of the aircraft. Of course, should power to the telescopic tunnel be interrupted when the rear doorway of the aircraft is engaged, it becomes impossible to move the aircraft away from the terminal building due to the wheel carriage blocking the path of the wing. Furthermore, the tunnel section is straight and therefore the floor of the cabin is at a lower level relative to the floor of the outermost tunnel section. Although this arrangement allows the telescopic tunnel section to clear the wing of the aircraft, the steps that are necessary for connecting the two floor sections would constitute an unacceptable barrier to universal accessibility.

[0015] Kubatzki in WO 0009395 discloses an over the wing bridge including at least one horizontally pivotal extension arm, which extension arm is mounted on a support. An access tunnel, including a device on the end thereof for docking to the aircraft, is coupled to the extension arm. Due to the length of the cantilevered section of the passenger bridge, the extension arm and support are necessarily structures of considerable size and complexity. Furthermore, the support structure severely limits the ability of the bridge to pivot horizontally.

[0016] Worpenberg in WO 0055040 discloses an over-the-wing bridge including a telescopic tunnel section that can be swiveled over the wing of an aircraft and which is supported by an extension arm that is fixedly or moveably mounted on a frame. The telescopic tunnel section is straight, and as such the inboard end of the tunnel section must be at a higher level relative to the

outboard end of the tunnel section in order to engage the rear doorway of an aircraft whilst maintaining acceptable clearance above the aircraft wing. This may result in the upward slope of the telescopic tunnel section toward the terminal being unacceptably steep.

[0017] FMT Aircraft Gate Support Systems of Sweden has recently implemented a dual-door, over-the-wing loading bridge. The bridge includes a passageway extending from a rotunda and which can be cantilevered over the wing of an aircraft to mate a cabin at the outboard end of the passageway to a rear doorway of the aircraft. The passageway is supported at a variable height by an adjustable wheel carriage in front of the wing and is permanently arched at a predetermined angle. Accordingly, vertical swinging motion occurs only at a point where the bridge is mounted to a fixed structure, such as one of a rotunda and a terminal building. It is a disadvantage that for certain combinations of fixed structure access height and aircraft rear doorway position, servicing the rear doorway is awkward or impossible due to the limited vertical motion of the cabin end.

[0018] It would be advantageous to provide an over-the-wing aircraft loading bridge that overcomes the above-mentioned disadvantages associated with the prior art.

Object of the Invention

[0019] In an attempt to overcome these and other limitations of the prior art it is an object of the instant invention to provide a flexible over-the-wing passenger loading bridge for servicing a rear doorway of a nose-in parked aircraft.

[0020] In an attempt to overcome these and other limitations of the prior art it is an object of the instant invention to provide a flexible over-the-wing passenger loading bridge that can be used in cooperation with a known passenger loading bridge to increase passenger flow rates to and from an aircraft.

Summary of the Invention

[0021] In accordance with an aspect of the instant invention there is provided a passenger loading bridge for servicing an aircraft having a rear doorway aft of or over a wing, comprising: a first passageway member pivotally coupled at an inboard end thereof to a rotunda and

supported close to an outboard end thereof by a ground support member; a telescopic passageway member having an inboard end and an outboard end and including at least two passageway elements, one that is telescopically received within the other such that a distance between the inboard end and the outboard end of the telescopic passageway member is variable, the telescopic passageway member for being supported in a cantilever-like fashion such that the telescopic passageway member is extensible over the wing of the aircraft; a flexible connection for pivotally coupling the outboard end of the first passageway member and the inboard end of the telescopic passageway member, and for supporting a vertical swinging motion of the outboard end of the telescopic passageway member relative to the first passageway member; an adjustable support mechanism mounted at a first end thereof to a surface of the first passageway member and mounted at a second opposite end thereof to a surface of the telescopic passageway member, for vertically swinging the telescopic passageway member relative to the first passageway member in a controllable manner; an actuator coupled to the adjustable support mechanism, for driving the adjustable support mechanism so as to vertically swing the telescopic passageway member relative to the first passageway member in the controllable manner; and, an electrical controller for providing a control signal to the actuator, the electrical control signal for use by the actuator to controllably vary the angle between the first passageway member and the telescopic passageway member about the flexible connection.

[0022] In accordance with an aspect of the instant invention there is provided A method of automatically aligning a passenger loading bridge to an aircraft having a rear doorway aft of or over a wing, comprising: providing a passenger loading bridge having an aircraft engaging end, the aircraft engaging end including a first passageway member that is coupled at an outboard end thereof to an inboard end of a telescopic passageway member via a flexible connection; automatically moving the aircraft engaging end of the passenger loading bridge over the wing of the aircraft and toward an expected stopping position for the rear doorway of the aircraft, the aircraft parked at a parking area adjacent to the passenger loading bridge; providing a control signal to an actuator of the passenger loading bridge, the control signal for use by the actuator for driving an adjustable support mechanism of the passenger loading bridge; and in dependence upon the provided control signal, controllably adjusting the adjustable support mechanism so as to effect a change to an angle between the first passageway member and the telescopic passageway member about the flexible connection, such that a known minimum clearance is

maintained between the aircraft engaging end of the passenger loading bridge and the wing of the aircraft.

[0023] In accordance with an aspect of the instant invention there is provided A passenger loading bridge for servicing an aircraft having a rear doorway aft of or over a wing, the passenger loading bridge comprising: a first passageway member having a length, an inboard end and an outboard end distal from the inboard end, the first passageway member pivotally coupled at the inboard end thereof to a rotunda, the outboard end for being positioned in a direction toward an aircraft; a telescopic passageway member having an inboard end and an outboard end and including at least two passageway elements, one that is telescopically received within the other such that a distance between the inboard end and the outboard end of the telescopic passageway member is variable, the telescopic passageway member for being supported in a cantilever-like fashion such that the telescopic passageway member is extensible over a wing of an aircraft; a flexible connection disposed between the first passageway member and the telescopic passageway member for pivotally coupling the outboard end of the first passageway member and the inboard end of the telescopic passageway member, for supporting a vertical swinging motion of the outboard end of the telescopic passageway member relative to the inboard end of the telescopic passageway member and about an approximately horizontal axis; and, a height-adjustable support member mounted to an external surface of the first passageway member at a point along the length of the first passageway member that is distal from the outboard end of the first passageway member, such that the flexible connection is positionable above and approximately aligned with a highest point of a wing of an aircraft.

[0024] In accordance with an aspect of the instant invention there is provided a passenger loading bridge for servicing an aircraft having a rear doorway aft of or over a wing, the passenger loading bridge comprising: a first passageway member pivotally coupled at an inboard end thereof to a rotunda and supported close to an outboard end thereof by a ground support member; a telescopic passageway member having an inboard end and an outboard end and including at least two passageway elements, one that is telescopically received within the other such that a distance between the inboard end and the outboard end of the telescopic passageway member is variable, the telescopic passageway member for being supported in a cantilever-like fashion such that the telescopic passageway member is extensible over the wing of an aircraft; a

flexible connection for pivotally coupling the outboard end of the first passageway member and the inboard end of the telescopic passageway member, for supporting a vertical swinging motion of the outboard end of the telescopic passageway member relative to the first passageway member; and, an adjustable support system comprising: at least a lift mechanism having a first end and a second end that is opposite the first end, a distance between the first end and the second end being controllably variable, the first end of the at least a lift mechanism pivotally mounted to a surface of the first passageway member at a location elevationally below a ceiling member thereof and proximate an end thereof, and the second end of the at least a lift mechanism pivotally mounted to a surface of the telescopic passageway member at a location elevationally below a ceiling member thereof and proximate an end thereof, the end of the first passageway member and the end of the telescopic passageway member being disposed in a facing arrangement one each on opposite sides of the flexible connection, such that varying the distance between the first end and the second end of the at least a lift mechanism effects a change to the angle between the first passageway member and the telescopic passageway member about the flexible connection.

Brief Description of the Drawings

[0025] Exemplary embodiments of the invention will now be described in conjunction with the following drawings, in which similar reference numbers designate similar items:

[0026] Figure 1a is a top plan view showing a loading bridge according to the instant invention in a stowed position relative to a nose-in parked aircraft;

[0027] Figure 1b is a side view of the loading bridge shown in Figure 1a;

[0028] Figure 2a is a top plan view showing a loading bridge according to the instant invention in an aircraft engaging position relative to a nose-in parked aircraft;

[0029] Figure 2b is a side view of the loading bridge shown in Figure 2a;

[0030] Figure 3a is a top plan view showing a loading bridge according to a second embodiment of the instant invention in a stowed position relative to a nose-in parked aircraft;

[0031] Figure 3b is a side view of the loading bridge shown in Figure 3a;

[0032] Figure 3c is a top plan view showing a loading bridge according to a third embodiment of the instant invention in a stowed position relative to a nose-in parked aircraft;

[0033] Figure 3d is a side view of the loading bridge shown in Figure 3c;

[0034] Figure 4a is a detailed view of part of the loading bridge shown in Figure 3a in a straight configuration;

[0035] Figure 4b is a detailed view of part of the loading bridge shown in Figure 3a in a bent configuration;

[0036] Figure 5 is a top plan view of an aircraft loading apparatus according to the instant invention;

[0037] Figure 6 is a top plan view of another aircraft loading apparatus according to the instant invention;

[0038] Figure 7a is a side view of a prior art over the wing bridge being cantilevered over a wing of an aircraft equipped with winglets;

[0039] Figure 7b is a side view of an over the wing bridge according to the instant invention, being cantilevered over a wing of an aircraft equipped with winglets;

[0040] Figure 8 shows a method of mating the over the wing loading bridge to the rear doorway of the aircraft, according to the instant invention;

[0041] Figure 9 shows a side elevational view of another aircraft loading apparatus according to the instant invention;

[0042] Figure 10 shows a simplified flow diagram of another method of mating the over the wing loading bridge to the rear doorway of the aircraft, according to the instant invention;

[0043] Figure 11a shows a detailed view of part of a passenger loading bridge according to another embodiment of the instant invention in a straight configuration;

[0044] Figure 11b shows the part of the passenger loading bridge of Figure 12a in a downwardly-inclined configuration; and,

[0045] Figure 11c shows the part of the passenger loading bridge of Figure 12a in an upwardly-inclined configuration.

Detailed Description of the Invention

[0046] The following description is presented to enable a person skilled in the art to make and use the invention, and is provided in the context of a particular application and its requirements. Various modifications to the disclosed embodiments will be readily apparent to those skilled in the art, and the general principles defined herein may be applied to other embodiments and applications without departing from the spirit and the scope of the invention. Thus, the present invention is not intended to be limited to the embodiments disclosed, but is to be accorded the widest scope consistent with the principles and features disclosed herein.

[0047] Throughout the detailed description and in the claims, it is to be understood that the following definitions shall be accorded to the following terms. The term ‘inboard end’ refers to that end of a passageway nearest a stationary structure, for instance one of a terminal building and a stationary rotunda. The term ‘outboard end’ refers to that end of a passageway nearest an aircraft doorway.

[0048] Referring to Figures 1a and 1b, shown is a loading bridge according to the instant invention in a stowed position relative to a nose-in parked aircraft. Figure 1a shows a top plan view of the loading bridge. The loading bridge comprises a stationary rotunda 4 from which extends a passageway 1 ending with a pivotal cabin 8 for mating to a rear doorway 9 of an aircraft 10. The passageway 1 comprises a fixed-length passageway member 2 and a telescopic tunnel section 21. The fixed-length passageway member 2 includes a floor, two sidewalls and a ceiling. The telescopic tunnel section 21 includes outer and inner tunnel elements 6 and 7, wherein the inner element 7 is telescopically received within the outer element 6 such that the length of the tunnel section 21 is variable. Each tunnel element 6 and 7 includes a floor, two sidewalls and a ceiling. Preferably, the fixed-length passageway member 2 and the outer tunnel element 6 have substantially similar cross-sectional profiles when viewed end-on. A flexible

connection including a bellows-type canopy 12 and a floor connector 11 connects the outboard end of the passageway member 2 and the inboard end of the outer tunnel element 6. The flexible canopy 12 is provided between the passageway member 2 and the outer tunnel element 6 to provide weatherproof protection to passengers passing therebetween. Optionally, the flexible connection includes a floor plate (not shown) to provide a level surface over which passengers move through the bridge. The flexible connection permits vertical swinging of the telescopic tunnel section 21 about a horizontal axis passing through the floor connector 11.

[0049] The loading bridge is for being cantilevered and extended over the wing of the nose-in parked aircraft 10 to service the rear doorway 9. Accordingly, the inboard end of the passageway member 2 is pivotally anchored to the stationary rotunda 4, preferably being at more or less the same elevation as the doorways in the aircraft 10. The passageway member 2 is supported near the outboard end thereof by a wheel carriage including a height adjustable support post 19 and drive wheels 3. The drive wheels 3 are for achieving angular displacement of the passageway 1. Additional mechanisms (not shown) are provided for slidingly extending and retracting the inner tunnel element 7 relative to the outer tunnel element 6, to thereby affect the length of the passageway 1, and for pivoting the pivotal cabin 8. The height adjustable support post 19 preferably includes one of a hydraulic cylinder, a pneumatic cylinder and a screw jack. Of course, other known mechanisms for moving the various bridge components relative to other bridge components are envisaged for use with the instant invention, selection of such mechanisms being purely a matter of design choice.

[0050] As shown in Figure 1a, the rotunda 4 opens onto a stationary bridge structure 5 leading to a terminal building (not shown). The stationary bridge structure 5 includes a nose-loader type bridge 30 for simultaneously servicing a front doorway 31 of the aircraft 10. Optionally, the nose-loader type bridge 30 is replaced by one of a radial bridge and an apron drive bridge for simultaneously servicing a front doorway 31 of the aircraft 10. Preferably, the provided one of a nose-loader, radial and apron drive bridge is mated to the front doorway 31 of the aircraft 10 in a fully automated manner using an automated bridge alignment system (not shown). An automated bridge alignment system suitable for use with the instant invention is disclosed in co-pending United States patent application, Serial Number 10/025,500, filed December 26 2001 in

the name of the Hutton and which is incorporated herein by reference. Further optionally, the rotunda 4 opens directly onto a terminal building concourse.

[0051] Referring to Figure 1b, shown is a side view of the loading bridge of Figure 1a. As shown in Figure 1b, overhead support means are provided for raising and lowering the cabin end of the telescopic tunnel section 21. In a first preferred embodiment shown in Figure 1b the support means comprises a cable 13 attached at a first end to a bracket 14, which bracket 14 is mounted to a roof surface near the outboard end of the outer tunnel segment 6. The cable 13 is passed over a bearing member 15, which is preferably disposed atop a support tower 16, and attached at a second end to an adjustable winch 17. The action of winding additional cable onto the winch causes the cabin-end to rise, whereas winding cable off of the winch causes the cabin-end to lower. Preferably more than one cable is used. In a most preferred embodiment, two cables are used, which provides improved stability during operation and reduces the risk of a catastrophic failure in the event that one cable fails.

[0052] Optionally, the support means comprises a cable of fixed length, which cable is attached at a first end to a bracket mounted on a roof surface near the outboard end of the outer tunnel segment 6, and at a second opposite end to a second bracket mounted near the inboard end of the fixed-length passageway member 2. The cable passes over a bearing member (not shown), which is preferably disposed atop a height adjustable support tower (not shown) mounted near the outboard end of the fixed-length passageway member 2. Then, by extending the height adjustable support tower the cable is pushed up, thereby, causing the cabin-end to swing vertically upward. Similarly, retracting the height adjustable support tower causes the cabin-end to swing vertically downward.

[0053] Referring to Figure 2a, shown is a top plan view of a loading bridge according to the first embodiment of the instant invention in an aircraft engaging position relative to a nose-in parked aircraft. Elements labeled with the same numerals have the same function as those illustrated in Figure 1a. The passageway 1 is cantilevered over the wing of the aircraft 10 by driving the drive wheels 3 along an arcuate path in front of the wing and in a direction generally toward the aircraft. Of course, prior to the passageway 1 being cantilevered toward the aircraft, the height adjustable support post 19 of the wheel carriage is adjusted in order to raise the

passageway 1 to a height that provides a minimum safe clearance to the wing so as to avoid contact with the wing of the aircraft 10. Typically, this height is a safe distance above the highest point of the upper surface of the wing of aircraft 10. When in the aircraft engaging position, the passageway 1 extends from the rotunda 4 and over the wing of aircraft 10, such that pivotal cabin 8 mates to the rear doorway 9.

[0054] Furthermore, some models of aircraft include winglets that are attached proximate a tip of the wing of the aircraft. Said winglets extend substantially above the highest point of the upper surface of the wing of aircraft 10. Accordingly, it is necessary in such cases for the height adjustable support post 19 of the wheel carriage to be adjusted in order to raise the passageway 1 to a height that provides a minimum safe clearance to the winglets, so as to avoid contact with the winglets when the passageway 1 is being moved approximately horizontally toward or away from the aircraft. Preferably, the minimum safe clearance to the highest point of the upper surface of the wing is substantially similar to the minimum safe clearance to the winglets, requiring the passageway 1 to be capable of being raised by an additional amount equal to the height of the winglets. Preferably, the height adjustable support post 19 includes a mechanical stop such that, in the event of a catastrophic failure of the over the wing bridge, the height adjustable support post 19 “bottoms out” prior to the passageway 1 coming into contact with the wing of the aircraft. In a most preferred embodiment, an adjustable mechanical stop is provided such that the “bottom out” position is variable in dependence upon the position of passageway 1. For instance, the passageway 1 may be raised to clear the winglet at the tip of an aircraft wing when being cantilevered over the wing. In such an instance, the “bottom out” position must be higher than the “bottom out” position that is required when the passageway 1 is over a flat portion of the wing. One solution is to provide an adjustable mechanical stop that “bottoms out” at a predetermined distance below a current bridge height, wherein the predetermined distance is less than the minimum safe clearance that is maintained between the passageway 1 and any surface of the aircraft wing. In a most preferred embodiment, the height adjustable support post 19 includes an electrical controller for providing an electronic “bottom out” point prior to the mechanical “bottom out” point. An adjustable mechanical stop as described above preferably includes a cam for automatically raising a support member disposed within and/or external to the height adjustable support post 19, during the period of time when the passageway 1 is being moved over the winglet. The mechanical stop optionally includes an electromechanical screw

for raising and lowering the passageway 1, and which provides a “hard stop” in an event that power to the screw is interrupted, for instance the screw does not “wind down” absent power being provided thereto.

[0055] Referring to Figure 2b, shown is a side view of the loading bridge illustrated in Figure 2a. Elements labeled with the same numerals have the same function as those illustrated in Figure 1b. As discussed *supra*, Figure 2b shows the outboard end of passageway member 2 being elevated a safe distance above the highest point of the upper surface of the wing of aircraft 10. Advantageously, the wheel carriage supports the passageway member 2 at a point close to the leading edge of the aircraft wing, with the passageway member 2 extending only a short distance beyond. As such, the floor connector 11 of the flexible connection is substantially positioned above the highest point of the upper surface of the wing of aircraft 10. The support means adjust the height of the cabin end of the passageway 1 in order to mate the cabin 8 to the doorway 9, allowing the passageway 1 to maintain a predetermined threshold clearance above the rearwardly downwardly sloping contour of the wing.

[0056] Preferably, the telescopic tunnel section 21 is substantially collinear with the passageway member 2 during the period of time that the passageway 1 is being cantilevered over the wing of the aircraft 10. Optionally, the telescopic tunnel section 21 is locked at some predetermined angle relative to the passageway member 2, such that the passageway 1 clears the wing of aircraft 10. Said angle is variable in dependence upon whether or not the aircraft being serviced by the passageway 1 includes winglets attached near the tips of the wings. A sensor (not shown), preferably a plurality of sensors, including but not limited to laser range finders, echo sonography sensors, inductive proximity sensors, etc. are disposed along the passageway 1 in order to sense critical distances, such as for example a distance between an aircraft component and the passageway 1. In response to a sensor sensing an approach of a passageway section to within a predetermined threshold value, the sensor transmits a control signal to a bridge controller (not shown). The control signal is for initiating a corrective action, such as for instance one of moving the entire bridge away from the aircraft and stopping the motion of the bridge. Of course, once the cabin 8 is mated to the doorway 9 of the aircraft 10, the sensors continue to monitor critical distances as the aircraft is loaded and/or unloaded. Accordingly, the sensors also transmit automatic control signals for adjusting the relative positions of the tunnel

segments as the aircraft raises and lowers during the above-mentioned operations, a function known as autoleveling.

[0057] Optionally, an automated bridge control system is provided for adjusting the relative positions of the tunnel segments during the initial process of aligning the cabin 8 to the doorway 9 of the aircraft 10. One such automated bridge control system is disclosed in the co-pending United States patent application discussed *supra*.

[0058] Optionally, a second telescopic passageway (not shown) replaces the fixed-length passageway member 2, such that the floor connector 11 may be positioned more precisely above the high point of the wing contour. This is particularly advantageous when a same bridge is used to service aircraft of different lengths. For example, a 737-900 is approximately 45 feet longer than a 737-100. In the case of a 737-900, the front doorway is moved forward relative to the wing and the rear doorway is moved rearward relative to the wing, compared to for example the 737-100. Accordingly, when each aircraft is parked such that the front doorway thereof is aligned with the nose-loader bridge 30, the leading edge of the wing is more distant from the rotunda 4 in the case of the 737-900 than in the case of the 737-100. By extending the second telescopic passageway toward the wing of the 737-900, the support post 19 and the floor connector 11 are better positioned relative to the wing of the aircraft, and the length of the telescopic tunnel section when it is moved over the wing to engage the rear doorway is minimized.

[0059] Referring to Figure 8, shown is a method of mating the over the wing loading bridge to the rear doorway of the aircraft, according to the instant invention. The over the wing loading bridge 1 occupies a stowed position prior to being used for servicing the aircraft 10, as shown in Figures 1a and 1b. When the aircraft 10 is assigned to a docking area adjacent the loading bridge 1, and when servicing of the rear doorway 9 is desired, a user of the bridge performs an optional step of enabling the automated bridge control system, to place the automated control system in a stand-by mode for aligning the cabin 8 of the loading bridge 1 with the rear doorway 9 of the aircraft 10. For instance, the user turns a key in a control panel or enters an alpha-numeric code via keypad of a control panel, to provide a control signal for enabling the automated bridge control system. Optionally, the control signal for enabling the automated bridge is provided

using a transmitter disposed aboard the aircraft. Alternatively, the automated bridge control system remains in an enabled mode.

[0060] When enabled, a processor of the automated bridge control system performs a step of determining a type of the aircraft 10 to be serviced. For instance, the processor extracts data indicative of the type of aircraft from the control signal, and/or an imaging system of the control system captures an image of the aircraft 10 and extracts features from the image for comparison by the processor to template data stored in a local database, to thereby make an independent determination of the type of the aircraft 10. The template data preferably is stored locally to the processor, such that substantially autonomous operation of the loading bridge 1 is possible.

[0061] In a next step, the processor retrieves other data relating to a predetermined minimum height profile for allowing the passenger loading bridge to maintain a minimum safe distance relative to the wing of the aircraft. The predetermined minimum height profile relates to a height of a point along the lower surface of the passenger loading bridge, at which height every point along the lower surface of the passenger loading bridge is at least the minimum safe distance above a corresponding point on the wing of the aircraft. Optionally, the imaging system is used to confirm the presence of winglets and/or other features extending above the surface of the wing of aircraft 10. The processor automatically corrects the predetermined minimum height profile in the event that an unexpected feature, such as for instance a winglet, is detected. Once the aircraft 10 has come to a stop at an expected stopping position adjacent the loading bridge 1, the automated control system automatically moves the bridge toward the expected stopping position of the rear doorway 9 of the aircraft 10, which requires that the telescopic tunnel section be moved in a cantilever fashion over the upper surface of the wing of the aircraft. Accordingly, an initial movement of the loading bridge 1 is for elevating the loading bridge such that a point along the lower surface thereof is at least a predetermined distance above the corrected predetermined minimum height profile, so as to maintain a minimum safe distance between the loading bridge and the wing of the aircraft during subsequent movement of the loading bridge 1. For example, the processor provides a control signal to the height adjustable support post 19 to extend said post 19, so as to elevate the outboard end of the fixed-length passageway member 2 above the corrected predetermined minimum height profile. Next, the processor provides a second control signal to the overhead support means. For example, a winch controller (not

shown) receives the second control signal and is actuated to either wind or unwind cable, so as to vertically swing the cabin end of the telescopic tunnel section 21 relative to the fixed-length passageway member 2, about the floor connector 11 of the flexible connection. In such a position, the telescopic tunnel section 21 and the fixed-length passageway member 2 forms an arch with sufficient height to clear the wing of the aircraft, including the winglet when present.

[0062] The remaining movement of the loading bridge 1 toward the aircraft 10 is also controlled by the automated control system, in order to mate the cabin 8 to the rear doorway 9. Preferably, sensors disposed on and/or about the loading bridge sense distances between the loading bridge and plural surfaces of the aircraft 10, and provide electrical control signals useable by the processor of the automated control system for adjusting the bridge movement so as to avoid a collision between the loading bridge and the aircraft. Of course, once the cabin 8 is mated to the rear doorway 9, the same and/or different sensors sense distance information relating to the aircraft, in order to provide electrical control signals useable by the processor of the automated control system for adjusting the loading bridge 1 as the aircraft raises or lowers during an unloading or a loading operation.

[0063] Referring to Figures 3a and 3b, shown is a loading bridge according to a second embodiment of the instant invention in a stowed position relative to a nose-in parked aircraft. Elements labeled with the same numerals have the same function as those illustrated in Figures 1a and 1b. According to the second embodiment, the overhead support means of Figure 1b is replaced by a linear actuator, for example including one of an extensible hydraulic cylinder 18, an extensible pneumatic cylinder (not shown) and an extensible electromechanical ball screw (not shown). The linear actuator includes one of the above-mentioned linearly actuatable mechanisms in communication with a suitable actuator for driving the particular linearly actuatable mechanism. For instance, the actuator is selected from a group including a pump and a reversible electric motor. An electrical controller is further provided in communication with the actuator, for providing a control signal theretor for use in driving the particular linearly actuatable mechanism. Preferably, at least two linear actuators are provided, one adjacent to each opposing side surface of the passageway 1. The bridge 20 according to the second embodiment of the instant invention works in a manner substantially analogous to that of the first embodiment. Once the passageway is cantilevered over the wing of aircraft 10, the linear

actuators 18 are actuated to raise or lower the cabin end of the passageway to the level of the rear doorway 9.

[0064] Referring now to Figure 4a and 4b, detailed views of a linear actuator 18 including a hydraulic cylinder 22 are shown. The hydraulic cylinder 22 is pivotally mounted to a sidewall surface of passageway member 2 using an anchor 21. An elongated piston 23 is telescopically received within the hydraulic cylinder 22 and is pivotally mounted to a sidewall surface of outer tunnel element 6 using an anchor 24. In Figure 4a, the passageway member 2 is substantially longitudinally aligned with outer tunnel element 6. As shown in Figure 4b, extending the piston causes the outboard end of tunnel element 6 to “lower”. Accordingly, the height of the cabin end of passageway 1 is controllable by extending and retracting the piston.

[0065] Referring to Figure 3c and 3d, shown is a loading bridge according to a third embodiment of the instant invention in a stowed position relative to a nose-in parked aircraft. The third embodiment is similar to the second embodiment. According to the third embodiment, a rigid support 31 extends upward from the wheel carriage support post 19, and adjacent a sidewall surface of passageway member 2. A hydraulic cylinder 33 is pivotally mounted close to the top of support 31 using an anchor 22. An elongated piston 34 is telescopically received within the hydraulic cylinder 33 and is pivotally mounted to a sidewall surface close to the outboard end of outer tunnel element 6 using an anchor 35. Preferably, anchor 35 is pivotally mounted to a rigid floor support member (not shown) of outer tunnel element 6.

[0066] It is an unforeseen advantage of the apparatus described with reference to Figures 1 to 4 that, by including the flexible connection between the passageway member 2 and the telescopic tunnel section 21, the passageway 1 is substantially more flexible compared to prior art over-the-wing bridges having a rigid, slightly arched shape. As such, the apparatus according to the instant invention is connectible between a wider range of fixed structure doorway heights and aircraft rear doorway heights compared to the prior art bridges. It is a further advantage of the instant invention that, by supporting the passageway member 2 using a moveable ground support member, such as a wheel carriage, only the telescopic tunnel section 21 needs to be supported, for example using overhead support means or linear actuators. As such, the support means may

be considerably less complex, thereby reducing capital costs, avoiding construction of massive support structures, reducing maintenance costs and improving reliability.

[0067] Optionally, the telescopic tunnel section 21 includes more than two tunnel elements, for instance three tunnel elements. As will be obvious to one of skill in the art, additional tunnel elements extend the length of the passageway, thereby allowing the bridge to service rear doorways of stretch aircraft models, etc. Further optionally, additional flexible connections are provided along the length of the passageway, including mechanisms for changing the inclination of connected tunnel elements. For example, a flexible connection is provided between a first tunnel element and a second tunnel element and between the second tunnel element and a third tunnel element of a telescopic tunnel section comprising three tunnel elements. The additional flexibility of the passageway allows individual tunnel elements to be sloped less steeply, thereby improving accessibility and safety.

[0068] Of course, all embodiments illustrated above include a nose-loader type bridge for servicing a doorway in front of the wing of aircraft 10. Accordingly, following an initial connection operation, passengers may move quickly between a terminal building and the aircraft 10 via either one of the front and rear doorways. Preferably, airline employees direct a passenger to use one of the front doorway and the rear doorway, depending upon a predetermined seating assignment of the passenger, so as to avoid unnecessary intermingling of passengers along the airplane aisle or aisles. Optionally, an automated system including signs, boarding pass scanners, etc. is used to direct passenger travel flow onto and/or off of the aircraft 10. Further optionally, one of a radial type bridge and an apron drive bridge is provided in place of the nose-loader, as discussed in greater detail with reference to Figure 5 and Figure 6, respectively, below.

[0069] As noted above, the front doorways of aircraft are often moved forward relative to the wing as the overall length of the aircraft increases. This is in addition to the rear doorways being moved rearward relative to the wing. Accordingly, it would be advantageous to provide an apparatus having a passenger loading bridge that can be pivoted and extended in order to engage a front doorway of plural types of aircraft, each type of aircraft being of a different length, thereby minimizing the amount of extension of an over the wing bridge portion that is required to engage a rear doorway of a same type of aircraft.

[0070] Referring to Figure 5, shown is a top plan view of an aircraft loading apparatus according to the instant invention. The apparatus includes an over the wing portion shown generally at 50 for servicing a rear doorway 9 of a nose-in parked aircraft 10 at a terminal building 61. The apparatus further includes a radial type bridge portion shown generally at 51 for servicing a front doorway 31 of the nose-in parked aircraft 10. The over the wing portion 50 and the radial type bridge portion 51 are coupled via a unitary passageway element 52 to each other and to an access portal 62 of the terminal building 61.

[0071] The over the wing portion 50 comprises a first passageway member 56 pivotally mounted at an inboard end to a rotunda 54 and supported near an outboard end by a wheel carriage 64 having a height adjustable support member (not shown) and driving wheels 68 for achieving angular displacement of the over the wing portion 50. The first passageway member 56 is also pivotally coupled at the outboard end to a telescopic passageway member 63 via a flexible floor connection 11 for allowing a vertical swinging motion of the telescopic passageway member 63, to align a cabin 59 mounted at an outboard end of the telescopic passageway member 63 with the doorway 9. Support means (not shown) are provided for adjustably controlling the vertical swinging motion. Of course, other mechanisms (not shown) are provided for adjusting the height of the over the wing portion 50, for extending and retracting the telescopic passageway member 63, etc. In a preferred embodiment, the over the wing portion 50 is aligned with the doorway 9 in an automated fashion. To this end, a bridge controller (not shown) is also provided for receiving data from sensors (not shown) mounted on or about the over the wing portion 50 and for providing control signals to the mechanisms. In a preferred embodiment, the portion 50 is aligned with the doorway 9 absent any human intervention. In another preferred embodiment, a human operator is required to perform one of an enable and a disable operation prior to the portion 50 being aligned to the doorway 9. For instance, the human operator turns a key in a control panel (not shown) or enters an alphanumeric code via a key pad (not shown) to enable the automated alignment system. Optionally, a control signal for enabling the automated bridge is provided using a transmitter disposed aboard the aircraft. In particular, flights that are only partially full may not require use of the over the wing portion 50, or alternatively certain airlines may not approve use of the over the wing portion with their aircraft. Of course, optionally the cabin 59 is pivotally mounted at the outboard end of the over the wing portion 50.

[0072] The radial type bridge portion 51 includes a fixed-length passageway member 55, which is mounted at an inboard end thereof to a rotunda 53 and supported at an outboard end by a wheel carriage 65 having a height adjustable support member (not shown) and driving wheels 67 for achieving angular displacement of the radial type bridge portion 51. The fixed-length passageway member 55 is telescopically coupled to a second passageway member 66, such that the length of the radial type bridge portion 51 is variable. A cabin 58 is mounted at an outboard end of the second passageway member 66 for engaging the doorway 31. The radial type bridge portion 51 is aligned to the doorway 31 in one of a manual, semi-automated, tele-robotic and automated manner. Optionally, a bridge controller (not shown) is also provided for receiving data from sensors (not shown) mounted on or about the radial bridge type portion 51 and for providing control signals to the mechanisms. Of course, a number of passageway members other than two may be envisaged for use with the radial type bridge portion 51 of instant invention.

[0073] Figure 6 is a top plan view of another aircraft loading apparatus according to the instant invention. Elements labeled with the same numerals have the same function as those illustrated in Figure 5, and their description is omitted here for clarity. The apparatus includes an over the wing portion shown generally at 50 for servicing a rear doorway 9 of a nose-in parked aircraft 10 at a terminal building 61. The apparatus further includes an apron bridge portion shown generally at 70 for servicing a front doorway 31 of the nose-in parked aircraft 10. The over the wing portion 50 and the apron bridge portion 70 are coupled via a unitary passageway element 71 to each other and to an access portal 62 of the terminal building 61.

[0074] The apron drive portion 70 includes a telescopic passageway member 78 comprising three passageway elements. Of course a number of passageway elements other than three may be envisaged for use with the instant invention. A first passageway element 73 is mounted at an inboard end to a rotunda 72. An outboard end of the first passageway element 73 is telescopically received within an inboard end of a second passageway element 74, and an outboard end of the second passageway element 74 is telescopically received within an inboard end of a third passageway element 75. The third passageway element 75 is supported near an outboard end thereof by a wheel carriage 76 having a height adjustable support member (not shown) and driving wheels 79 for achieving angular displacement of the apron drive portion 70 as well as telescoping of the passageway elements 73, 74 and 75 to alter the length of the apron

drive portion 70. A cabin 77 is mounted at an outboard end of the third passageway element 75 for engaging the doorway 31. Optionally, the cabin 77 is pivotally mounted at the outboard end of the third passageway element 75 and a mechanism (not shown) is provided for adjusting the orientation of the cabin relative to the third passageway element 75. The apron drive portion 70 is aligned to the doorway 31 in one of a manual, semi-automated, tele-robotic and automated manner. Optionally, a bridge controller (not shown) is also provided for receiving data from sensors (not shown) mounted on or about the apron drive portion 70 and for providing control signals to the mechanisms.

[0075] Of course, other known configurations of apron drive bridges are also envisaged for use with the instant invention. For instance, an apron drive bridge including at least two passageway members, one telescopically received within the other, is suitable for use with the instant invention.

[0076] Referring now to Figure 9, shown is a side elevational view of another aircraft loading apparatus according to the instant invention. The loading bridge, shown generally at 100, extends from a support in the form of, for example, a stationary rotunda 102. A passageway 104, ending with a pivotal cabin 106 for mating to a not illustrated rear doorway of a not illustrated aircraft, extends from the support. The passageway 104 comprises a fixed-length first passageway member 108 and a telescopic tunnel section 110. The fixed-length first passageway member 108 preferably includes a floor, two sidewalls and a ceiling. The telescopic tunnel section 110 includes outer and inner tunnel elements 112 and 114, respectively, wherein the inner element 114 is telescopically received within the outer element 112 such that the length of the tunnel section 110 is variable. Each tunnel element 112 and 114 preferably includes a floor, two sidewalls and a ceiling. Preferably, the fixed-length first passageway member 108 and the outer tunnel element 112 have substantially similar cross-sectional profiles when viewed end-on. A flexible connection 116 including a bellows-type canopy 118 and a floor connector 120 connects the outboard end of the first passageway member 108 and the inboard end of the outer tunnel element 112. For instance, a hinge is provided between the outboard end of the first passageway member 108 and the inboard end of the outer tunnel element 112, for pivotally mounting one to the other. The bellows-type canopy 118 is provided between the first passageway member 108 and the outer tunnel element 112 to provide weatherproof protection to

passengers passing therebetween. Optionally, the flexible connection 116 includes a floor plate (not shown) to provide a level surface over which passengers move through the bridge. The flexible connection 116 supports a vertical swinging motion of the telescopic tunnel section 110 about a horizontal axis passing through the floor connector 116, for instance a pivoting motion about the hinge.

[0077] The loading bridge 100 is for being cantilevered and extended over a not illustrated wing of a not illustrated nose-in parked aircraft, so as to service a rear doorway thereof. Accordingly, an inboard end of the first passageway member 108 is pivotally anchored to the stationary rotunda 102, preferably being at more or less the same elevation as the doorways along the lateral surface of the not illustrated aircraft. The first passageway member 108 is supported near the outboard end thereof by a wheel carriage 122 including a height adjustable support post 124 and drive wheels 126. The drive wheels 126 are for achieving angular displacement of the passageway 104. Additional mechanisms (not shown) are provided for slidingly extending and retracting the inner tunnel element 114 relative to the outer tunnel element 112, to thereby affect the length of the passageway 104, and for pivoting the pivotal cabin 106. The height adjustable support post 124 preferably includes one of a hydraulic cylinder, a pneumatic cylinder and a ball-screw jack. Of course, other known mechanisms for moving the various bridge components relative to other bridge components are envisaged for use with the instant invention, selection of such mechanisms being purely a matter of design choice. Preferably, the height adjustable support posts 124 are mounted at a point along the length of the first passageway member 108 that is between approximately 10 feet and approximately 3 feet from the outboard end of the first passageway member 108. Most preferably, the height adjustable support posts 124 are mounted at a point along the length of the first passageway member 108 that is between approximately 8 feet and approximately 4 feet from the outboard end of the first passageway member 108. Mounting the height adjustable support posts 124 at a point distal from the outboard end of the first passageway member advantageously allows the wing of the aircraft to approach more closely to the flexible connection, absent any obstacles such as for instance one of a support post and a bridge supporting pedestal.

[0078] An overhead support system 128 is provided for supporting the telescopic tunnel section 110 relative to the passageway member 108. The overhead support system 128 is also

for supporting a vertical swinging motion of an outboard end of the telescopic tunnel section 110 relative to an inboard end of the telescopic tunnel section 110. Preferably, the overhead support system 128 includes two ball-screw jacks 130a, 130b supported as shown in Figure 9. Each ball-screw jack is rotatably coupled to a motor 132a, 132b, respectively, which are coupled one-to-the other via a drive-shaft 134. The drive-shaft 134 ensures that both motors turn at a same speed, such that both sides of the telescopic tunnel section 110 are raised or lowered at a same rate. A first end of the ball-screw jack 130b is coupled to the outer tunnel element 112 via first and second support members 136, 138, respectively. A second end of the ball-screw jack 130b is similarly coupled to the first passageway member 108 via third and fourth support members 140, 142, respectively. Reducing the distance between the first and second ends of the ball-screw jack 130b reduces the angle formed between the first 136 and third 140 support members, thereby elevating the outboard end of the telescopic tunnel section 110 in a controlled fashion. Conversely, increasing the distance between the first and second ends of the ball-screw jack 130b increases the angle formed between the first 136 and third 140 support members, thereby lowering the outboard end of the telescopic tunnel section 110 in a controlled fashion. Of course, ball-screw jack 130a is supported and operated in a manner analogous to that of ball-screw jack 130b.

[0079] The instant invention described above with reference to Figures 1-6 and Figure 9 discloses an over the wing bridge for servicing a rear doorway of an aircraft, wherein a flexible floor connection is provided between a first passageway member and a telescopic passageway member of a passageway. It is an advantage of the instant invention that the flexible floor connection is positionable close to the leading edge and/or highest point of the wing contour, such that the passageway may be cantilevered over the wing of the aircraft to engage the rear doorway thereof, whilst maintaining a safe clearance distance between the wing surface and the passageway. It is a further advantage that, when used in connection with an aircraft having winglets 80 attached near a tip of each wing 81, the bridge may still be cantilevered over the wing without requiring the cabin end of the bridge to project substantially into the air. In fact, the tops of the winglets of a 737 type aircraft are approximately 20 feet above the ground. Referring now to Figure 7a, shown is a prior art over the wing bridge 83 being cantilevered over the wing 81 of an aircraft having winglets 80 attached thereto. The cabin end 82 of the non-flexible over the wing bridge 83 extends substantially higher than the tops of the winglets. This

situation is undesirable, especially when operating under windy or adverse conditions. Referring now to Figure 7b, shown is a flexible over the wing bridge 90 according to the instant invention being cantilevered over the wing 81 of an aircraft having winglets 80 attached thereto. A first passageway member 84 slopes upward from a rotunda 85 to a height for providing safe clearance to the winglet 80, and the flexible floor connection 11 allows the telescopic passageway member 86 to swing vertically downward from said height, such that the cabin end 87 is approximately 20 feet above the ground or less.

[0080] Referring now to Figure 10, shown is a simplified flow diagram of another method of mating the over the wing loading bridge to the rear doorway of the aircraft, according to the instant invention. At step 200, an aircraft is stopped adjacent to the passenger loading bridge. At step 202, an automated bridge control system is enabled, for instance by providing a password using a user interface device in communication with the bridge control system. Optionally, a control signal for enabling the automated bridge control system is provided using a transmitter disposed aboard the aircraft. At step 204 the type of the aircraft is provided to the bridge control system. For instance, a touch screen is used to select a type of aircraft from a plurality of different aircraft types. At step 206, the boarding bridge is moved automatically under the control of the bridge control system such that a highest point along a wing of the aircraft is disposed approximately below a flexible connection of the passenger loading bridge and to engage a rear doorway of the aircraft. At step 208, an angle between two tunnel sections of the passenger loading bridge, the two tunnel sections being disposed one each on opposite sides of the flexible connection, is adjusted such that a slope of a floor member of each one of the two tunnel sections is within a predetermined range of threshold values. For instance, the relative angle between the first passageway member 108 and the telescopic tunnel section 110 is optimized, such that neither the passageway member 108 nor the telescopic tunnel section 110 slopes at more than 1:12.

[0081] Preferably, every point along a lower surface of the passenger loading bridge is at least a predetermined minimum safe distance above a corresponding point on the wing of the aircraft when the doorway aft of the wing of the aircraft is engaged. Most preferably, a distance between the lower surface of the passenger loading bridge and a corresponding point on the wing of the aircraft is sensed, and the height of the passenger loading bridge is adjusted during the time that

the doorway aft of the wing of the aircraft is engaged. In this way, the at least a predetermined minimum safe distance is maintained between every point along the lower surface of the passenger loading bridge and the corresponding point on the wing of the aircraft. Preferably, the step of adjusting a height of the passenger loading bridge comprises the step of adjusting a height of the flexible connection relative to the wing, whilst the door is maintained in an engaged condition with the passenger loading bridge. Preferably, when the flexible connection is raised relative to the wing, the telescopic tunnel section 110 is simultaneously extended such that an angle between the first passageway member 108 and the telescopic tunnel section 110 is reduced. Preferably, when the flexible connection is lowered relative to the wing, the telescopic tunnel section 110 is simultaneously retracted such that an angle between the first passageway member 108 and the telescopic tunnel section 110 is increased. Accordingly, the flexible connection, in combination with the placement of the height adjustable support posts 124 at a distance that is remote from the outboard end of the first passageway member 108, provides a highly flexible passenger loading bridge for servicing aircraft doorways aft of a wing.

[0082] Optionally, the invention according to any of the above-described embodiments is operable in an automated manner, for example by providing an automated bridge control system. One such automated bridge control system is disclosed in the co-pending United States patent application discussed *supra*. Of course, each one of the above-mentioned apparatus includes a first moveable bridge for servicing a front doorway of an aircraft and an over the wing bridge for servicing a rear doorway of a same aircraft. The first moveable bridge and/or the over the wing bridge are alignable to the corresponding doorway of the same aircraft in one of a manual fashion and an automated fashion. Advantageously, the first moveable bridge may be aligned to the front doorway of the aircraft in the automated fashion using the automated bridge control system, once the aircraft has come to a stop and absent any ground personnel intervention. A member of the flight crew of the aircraft then optionally deplanes via the front doorway and enables the automated bridge control system to align the over the wing bridge to the rear doorway of the same aircraft. Optionally, a control signal for enabling the automated bridge control system is provided using a transmitter disposed aboard the aircraft.

[0083] Referring now to Figures 11a, 11b, and 11c, shown are detailed views of part of a passenger loading bridge according to another embodiment of the instant invention in a straight

configuration, in a downwardly-inclined configuration, and in an upwardly-inclined configuration, respectively. For example, a linearly adjustable mechanism in the form of a fluid pressure ram 300 is provided for adjustably supporting one passageway member 302 relative to a second passageway member 304. Each passageway member 302, 304 includes a floor member, a ceiling member and two opposite sidewall members. A hinge 306 is disposed between the ceiling member of the passageway member 302 and the ceiling member of the passageway member 304, for supporting a vertical swinging motion of an outboard end of the passageway member 304 relative to the passageway member 302. To this end, the linearly adjustable mechanism is pivotally anchored at one end thereof to the passageway member 302, and is pivotally anchored at an opposite end thereof to the passageway member 304. The adjustable mechanism is in communication with a not illustrated actuator, such as for example a pump, for driving the adjustable mechanism. Additionally, a not illustrated electrical controller is provided in communication with the actuator for providing a control signal thereto; the control signal for use by the actuator for adjusting an angle between the passageway member 302 and the passageway member 304 about the hinge 306. Of course, a not illustrated adjustable walking surface is provided for supporting passenger travel between the passageway member 302 and the passageway member 304. Additionally, a flexible canopy 308 is provided for providing substantially continuous weather resistant protection to the passengers moving between the passageway member 302 and the passageway member 304. In Figure 11a, the passageway member 302 is substantially longitudinally aligned with the passageway member 304. As shown in Figure 11b, retracting the linearly adjustable mechanism causes the outboard end of passageway member 304 to “lower”. As shown at Figure 11c, extending the linearly adjustable mechanism causes the outboard end of passageway member 304 to “raise”. Accordingly, the height of the outboard end of passageway member 304 is controllable by extending and retracting the linearly adjustable mechanism.

[0084] Numerous other embodiments may be envisaged without departing from the spirit and scope of the invention.